

Explainable Artificial Intelligence based Verification & Validation for Increasingly Autonomous Aviation Systems, Phase I

Completed Technology Project (2018 - 2019)



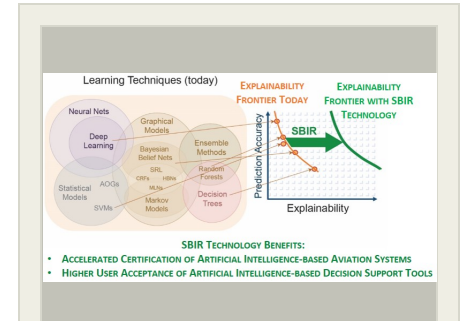
Project Introduction

Artificial Intelligence (AI) algorithms, which are the heart of emerging aviation autonomous systems and autonomy technologies, are generally perceived as black boxes whose decisions are a result of complex rules learned on-the-fly. Unless the decisions are explained in a human understandable form, the human end-users are less likely to accept them, and in the case of aviation applications, certification personnel are less likely to clear systems with increasing levels of autonomy for field operation. Explainable AI (XAI) are AI algorithms whose actions can be easily understood by humans. This SBIR develops EXplained Process and Logic of Artificial Intelligence Decisions (EXPLAIND), which is a prototype tool for verification and validation of AI-based aviation systems. The SBIR develops an innovative technique called Local Interpretable Model-Agnostic Explanation (LIME) for making the learning in AI algorithms more explainable to human users. LIME generates an explanation of an AI algorithm's decisions by approximating the underlying model in the vicinity of a prediction by an interpretable one. We apply LIME to a NASA-developed aircraft trajectory anomaly detection AI algorithm (MKAD) to provide a proof-of-concept. EXPLAIND represents an important step towards user acceptance and certification of multiple AI based decision support tools (DSTs) and flight-deck capabilities planned to be developed under NASA's System Wide Safety and ATM-eXploration projects. EXPLAIND also benefits NASA's planned human-in-the-loop (HITL) simulations of machine learning (ML) algorithms using the SMARTNAS Testbed by providing techniques for making the algorithm's decisions more understandable to HITL participants. Moreover, with new European Union regulations soon requiring that any decision made by a machine be readily explainable, the EXPLAIND approach is also relevant to multiple non-aviation fields such as medical diagnosis, financial systems, computer law, and autonomous cars.

Anticipated Benefits

Applications include enhanced explainability AI/ML algorithms for (1) aviation anomaly detection and safety precursor identification for Real-time System-wide Safety Assurance, (2) ATD-3's Traffic Aware Strategic Aircrew Requests (TASAR), (3) IDO traffic management, (4) UAM and UTM path planning, de-confliction, scheduling and sequencing, (5) AI explanation interfaces to support UAM and IDO HITLs using the SMARTNAS Testbed, (6) Science Mission Directorate's distant planet discovery algorithms.

Primary application is for the FAA with goal for NASA to transfer a validated enhanced explainability AI concept (e.g., MKAD anomaly detection tool) to the FAA. Airline AI travel assistant tools are another application. With new European General Data Protection Regulation requiring that any decision made by a machine be readily explainable, EXPLAIND can be applied to non-aviation fields like financial credit models, medical diagnosis, and self-driving car guidance systems.



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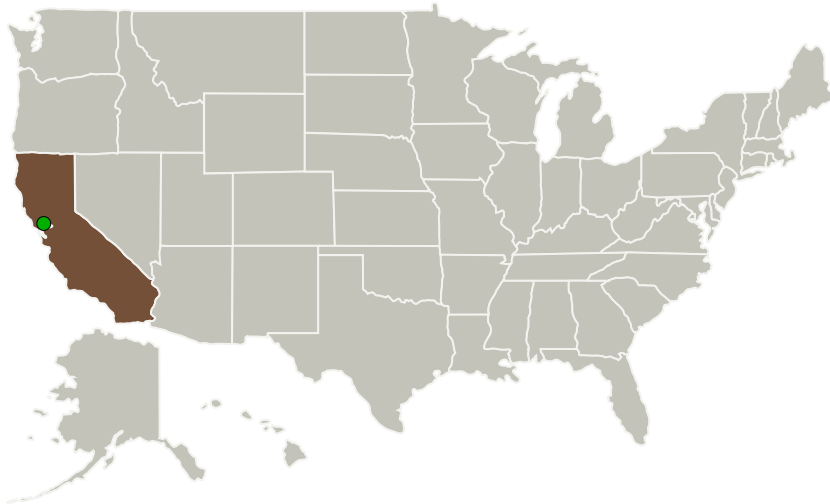
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
ATAC	Lead Organization	Industry	Santa Clara, California
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations

California

Project Transitions

**July 2018:** Project Start**February 2019:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/141044>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ATAC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

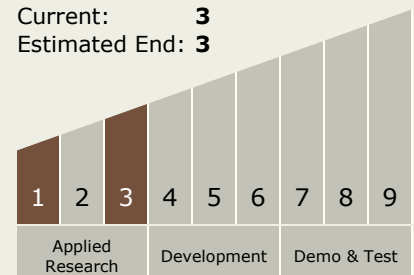
Carlos Torrez

Principal Investigator:

Aditya Saraf

Technology Maturity (TRL)

Start: **1**
 Current: **3**
 Estimated End: **3**

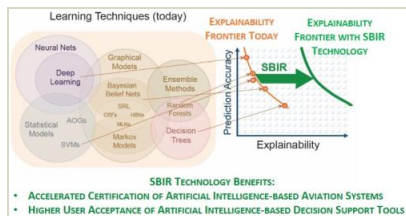


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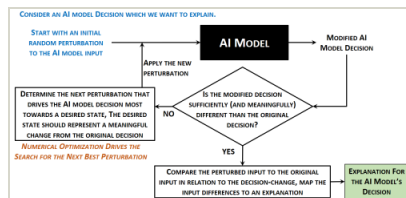


Images



Briefing Chart Image

Explainable Artificial Intelligence based Verification & Validation for Increasingly Autonomous Aviation Systems, Phase I
(<https://techport.nasa.gov/image/130676>)



Final Summary Chart Image

Explainable Artificial Intelligence based Verification & Validation for Increasingly Autonomous Aviation Systems, Phase I
(<https://techport.nasa.gov/image/132097>)

Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.3 Aero Propulsion
 - └ TX01.3.1 Integrated Systems and Ancillary Technologies

Target Destinations

Earth, Outside the Solar System